Solid-State Processing of Conjugated Polymer-Fullerene Blends

D. G. Bucknall (Georgia Tech), G Bernardo (Univ of Minho) and M Shofner (Georgia Tech)

If the future global future energy needs are to be met, renewable energies must be exploited. The possibility of cheap, but efficient organic or polymer based photovoltaic (OPV) devices are among the competing technologies, which are actively being studied. To date the most efficient OPV devices are based on conjugated polymer-fullerene bulk heterojunctions (BHJ). The choice of polymer and fullerene is a balance of electronic (donor-acceptor) properties, but due to the nature of the solubility of the species, also includes solubilising ligands. Whilst these ligands certainly induce improved solution processability, they can also affect the electronic characteristics and also morphology of the polymers and fullerenes. However, potentially interesting polymer-fullerene combinations are not being explored due to difficulties in solution processing of the mixtures.

We are exploring the use of pressure on the phase behaviour of polymer-fullerene blends, following on from previous workers who showed that melt processing of polymers can be greatly influenced by application of pressure. Under moderate pressure, we have demonstrated that equivalent phase behavior in polymer-fullerene pairs observed by conventional solution processing can be induced in solid-state processing. Using a combination of experiments and molecular modeling we are exploring the effect that pressure plays in inducing phase miscibility in otherwise intractable polymer-fullerene mixtures. To date we have been exploring a number of model-fullerene mixtures, but have demonstrated that the effects of this solid-state processing method are ubiquitous. The results of this fundamental study are expected to lead to alternative methods of processing of conjugated polymers without the need for solvents.